Deductive Exposition of EM Theory

Branko Mišković
Novi Sad, Serbia
aham.brami@gmail.com

***Abstract*—Inductive development of EM theory overlooked some aspects or details of this complex physical discipline. The reverse deductive exposition would further explain the former results. Starting from the founded supposition of a compressible, super-fluidic and inert medium, as the sufficient starting view, EM theory is here exposed deductively. The three mentioned fluid features enable static, kinetic and dynamic phenomena, respectively. All the physical quantities and their relations are convincingly interpreted aerodynamically.**

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I. Static Relations

Let a subtle fluid be taken as the substantial essence of 4D space, including particles, as its disturbances. Say that this medium is denser around positive, and sparser around negative particles. Tending to the fluid *homogeneity*, two equipolar particles repel, and opposite ones attract each other. The first and last fluid features, as its *elasticity* (ε) and *mass density* (μ), are the bases of the *static* and *dynamic* effects, dependent on a distance or acceleration, respectively, of the disturbances. As such, these two features determine the speed of EM wave propagation: $c^2 = 1/\varepsilon\mu$.

Internal pressure of the *compressible* fluid equals to the energy density, and each its disturbance, as the elementary *static potential*, provides the energy for all other such disturbances, as the *objects*. This quantity determines the *static field*, and this field itself – *carrying charge*:

$$\nabla\Phi = -\mathbf{E}_s\,, \qquad \nabla\cdot\mathbf{D} = Q\,. \tag{2}$$

Each new quantity in this sequence is the formal feature of the preceding one. The static field is the gradient of respective potential. The beginnings of the field lines represent the positive, and their terminals – negative charges. Static field thus mediates the relation of electric charge and respective potential. Thus introduced, the static quantities are the bases for following definition of kinetic ones.

II. Kinetic Relations

The medium *super-fluidity* enables continual fluid flows. In parallel to the *current field* definition (3b), the motion of a *static*, as the *pressure disturbance*, forms *kinetic* potential, as the *linear momentum* density (3a):

$$\mathbf{A} = \varepsilon\mu\Phi\mathbf{V}\,, \qquad \mathbf{J} = Q\mathbf{V}\,. \tag{3}$$

The product of the *compressibility* (ε), *regular density* (μ) and *pressure disturbance* (Φ) gives the *density disturbance* ($\varepsilon\mu\Phi$). The charges are inseparable from their potentials, and so the two kinetic quantities are collinear. At motion of negative static quantities, these two are opposite.

The equation (3a) defines the kinetic, by motion of static potentials. Let us now examine their mutual differential relation. Namely, *div*-operator applied directly to (3a) gives so called Lorentz' condition, as the continuity equation differentially relating the two EM potentials:

$$\nabla\cdot\mathbf{A} = \varepsilon\mu\,(\Phi\,\nabla\cdot\mathbf{V} + \mathbf{V}\cdot\nabla\Phi) = -\varepsilon\mu\,\partial_t\Phi\,. \tag{4}$$

Dilatation and *convection* of the static, determine the kinetic potentials. Following its carrying charge, the static potential behaves as a rigid structure, of the homogeneous speed. The former middle term thus annuls, with the *convective* derivative, $\mathbf{V}\cdot\nabla\Phi = -\,\partial_t\Phi$, in the latter term. This derivative is opposite to the gradient of a moving potential.

Two parallel fluid flows interact by mutual forces, and crosswise ones – by respective torque. These *kinetic* interactions, determined by transverse gradient or *curl* of the linear momentum density (4), are represented in EM theory by the *magnetic field*, defined by (5a). In the similar manner, its own *curl* will soon be identified as the current field, in all the three electric structural layers (5b):

$$\nabla\times\mathbf{A} = \mathbf{B}\,, \qquad \nabla\times\mathbf{H} = \mathbf{J}_{tot}\,. \tag{5}$$

Here $\mathbf{J}_{tot} = \mathbf{J} + \partial_t\mathbf{D}$ is the total current field consisting of the *convection* and *conduction* components – in the former, and *displacement* one – in latter terms, – at vacuum, conductors and dielectrics, respectively. Magnetic field is perpendicular to the other two (collinear) vectors.

In accord to the relations (3) of the two potentials or carriers, the fields, as their intermediate quantities, are similarly related. The substitution of (3a) into (5a) gives:

$$\mathbf{B} = \varepsilon\mu(\Phi\,\nabla\times\mathbf{V} - \mathbf{V}\times\nabla\Phi)\,, \qquad \mathbf{H} = \mathbf{V}\times\mathbf{D}\,. \tag{6}$$

In the case of rectilinear motion of the rigid static potential, the former term in (6a) annuls, and (2a) substituted into the latter term gives the *convective kinetic relation* (6b). *A moving electric, produces the magnetic field,* representing transverse kinetic forces. *Curl* applied to (6b), excluding spatial derivatives of the field speed, gives (5b):

$$\nabla\times\mathbf{H} = \mathbf{V}\,\nabla\cdot\mathbf{D} - \mathbf{V}\cdot\nabla\mathbf{D} = \mathbf{J} + \partial_t\mathbf{D}\,. \tag{5b'}$$

Here $\mathbf{V}\nabla\cdot\mathbf{D} = \mathbf{V}Q = \mathbf{J}$, and $\mathbf{V}\cdot\nabla\mathbf{D} = -\partial_t\mathbf{D}$ – the convective derivative of the moving electric field.

Instead of the kinetic potential and magnetic field, the *kinetic* interactions of respective quantities are expressed in EM theory by the *equivalent* static quantities, determined at least in the case of the parallel motion:

$$\Phi_k = -\mathbf{v}\cdot\mathbf{A}\,, \qquad Q_k = -\varepsilon\mu\,\mathbf{v}\cdot\mathbf{J}\,. \tag{7}$$

These equations are formally inverse to the definitions (3), with the product $\varepsilon\mu$ – consequently replaced. The negative signs point to the attractive (or repulsive) interactions. *Grad* applied to (7a), after missing of the spatial derivatives of the object speed, gives respective 'electric' field:

$$\mathbf{E}_\mathrm{k} = \mathbf{v}\cdot\nabla\mathbf{A} + \mathbf{v}\times\nabla\times\mathbf{A} = \mathbf{v}\times\mathbf{B}\,. \qquad (8)$$

By dot product in (7a), the motion is directed *along* the potential **A**, and thus, the former middle term usually annuls. Finally, *div* applied to (8) gives (7b), as the kinetic interaction of two parallel currents. However, (8) is generalized to the *transverse* direction too, as the torque tending to the same courses of two crosswise currents.

III. Dynamic Relations

With respect to the massive omnipresent quantum fluid, temporal derivative of the kinetic potential, as the linear momentum density, gives the reactive *dynamic* forces, represented by respective electric field:

$$\partial_t\mathbf{A} = -\mathbf{E}_\mathrm{d}\,, \qquad \nabla\times\mathbf{E} = -\partial_t\mathbf{B}\,. \qquad (9)$$

Curl applied to (9a), with respect to (5a), gives the *dynamic equation* (9b). Similarly, *div* applied to (5a), via mixed vector product, gives the trivial Maxwell's equation: $\nabla\cdot\mathbf{B}=0$. It only speaks against the existence of free magnetic poles, being possibly predicted in advance.

The kinetic potential and magnetic field are the two perpendicular vortical fields, and their gradient, perpendicular to the common surface, is a non-vortical field. The motion in this direction convectively varies the potential, and – with respect to (9a), induces the *dynamic* field:

$$\mathbf{E}_\mathrm{d} = -\partial_t\mathbf{A} = \mathbf{U}\cdot\nabla\mathbf{A} = \mathbf{B}\times\mathbf{U}\,. \qquad (10)$$

U is *transverse* speed of the field and potential, in the plains of the field lines, and so: $|\nabla\mathbf{A}| = |\nabla\times\mathbf{A}| = |\mathbf{B}|$. Therefore, *curl* applied to (10) directly gives (9b):

$$\nabla\times\mathbf{E}_\mathrm{d} = \mathbf{U}\cdot\nabla\mathbf{B} - \mathbf{U}\nabla\cdot\mathbf{B} = -\partial_t\mathbf{B}\,. \qquad (9b')$$

As before, the speed derivatives are missed. *Magnetic field motion in the planes of its lines induces the dynamic forces*, represented by respective electric field.

With respect to (7), a punctual charge, moving in direction of a carrying current, suffers the transverse kinetic force (8). However, with respect to (10), the current carrying conductor, moving in the same direction (of the zero gradient), would not cause any inductive effect. This direction does not obey the principle of relativity. Unlike apparent charge (7b), any real charge cannot be obtained by axial motion of a current, at least in the frames of 3D space.

The *dynamic convective relation* (10), together with *kinetic* one (6b), forms the convective pair introduced by J. J. Thomson. With respect to the above procedures, neglecting all the spatial derivatives of the field speeds, this pair is restricted to the *uniform rectilinear* motion. In addition of the above restriction of the direction of motion, these two relations were seeming to be problematic. This was the reason of their missing from the standard EM theory.

IV. Moving Fields

Instead of the field variation – in Maxwell's equations, the algebraic relations treat their motion. Moving electric, produces magnetic field (6), affecting *kinetically* the charges *moving in parallel* – by respective force (8):

$$\mathbf{E}_\mathrm{k} = -\varepsilon\mu E_\mathrm{s} V v \sin\theta\,\mathbf{i}_\mathrm{t}\,. \qquad (19)$$

Here θ is the polar angle between the direction of motion and the moving field itself. The obtained kinetic field just depends on the speed product. Possible transverse component of the object speed, with respect to the carrier's speed, would produce the axial force component.

With respect to Lorentz' condition (4), a moving kinetic potential causes some *dynamic* induction:

$$\mathbf{E}_\mathrm{d} = -\partial_t\mathbf{A} = \mathbf{V}\cdot\nabla\mathbf{A} = \mathbf{V}\nabla\cdot\mathbf{A} = -\varepsilon\mu E_\mathrm{s} V^2\cos\theta\,\mathbf{i}_\mathrm{l}\,. \qquad (20)$$

The longitudinal *grad* equals to *div*. Thus obtained dynamic field, independent of the object speed, is directed axially, towards the carrier. It points to some acceleration of the medium in the front, and its deceleration behind a moving charge. Subtracted from the moving static field, it causes the ellipsoidal field deformation. SRT ascribed this effect to the increased transverse field components.

The vector sum of the two components – kinetic (19) and dynamic (20) – affects all the present electric charges, including the causing charge itself:

$$\mathbf{E}_\mathrm{k} + \mathbf{E}_\mathrm{d} = -\varepsilon\mu E_\mathrm{s} V (v\sin\theta\,\mathbf{i}_\mathrm{t} + V\cos\theta\,\mathbf{i}_\mathrm{l})\,. \qquad (21)$$

In the resting frame ($v = 0$), this is reduced to the letter term. In the moving frame ($V = v$), vector sum of the two components represents the central field. Its subtraction from the moving static field as if scales this field:

$$\mathbf{E}' = (1-\varepsilon\mu v^2)\mathbf{E}_\mathrm{s} = g^2\mathbf{E}_\mathrm{s}\,. \qquad (22)$$

The transverse components, acting on the object charges, are scaled by the factor: $h = 1-\varepsilon\mu V v$. With some formal inconsistencies and fantastic interpretations, the two factors play the crucial roles in foundation of SRT.

V. Conclusion

Introduced in fluid dynamics of an omnipresent medium, all the basic laws of EM theory, as the former phenomenological postulates – in differential or algebraic forms, define and mutually relate all EM quantities. The three mentioned fluid features enable and logically determine all the static, kinetic & dynamic effects, respectively. The three EM fields are introduced by respective differential equations, and their mutual algebraic relations are thus consequently established. EM theory is finally presented as the central physical discipline, between other such disciplines, from the classical, up to the quantum mechanics. The ability of the full unification of the physics in general is thus pointed at.

References

[1] B. Mišković, *Inductive Elaboration of EM Theory*, ISTET 2013

[2] B. Mišković, *Electrodynamics...*, http://solair.eunet.rs/~brami/